Assessment of the outcome of mechanically ventilated chronic obstructive pulmonary disease patients admitted in the respiratory ICU in Ain Shams University Hospital

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Background Mechanical ventilation (MV) alters the outcome of patients with chronic obstructive pulmonary disease (COPD).

Aim This study aimed to assess the outcome of mechanically ventilated COPD patients admitted in the respiratory ICU and the factors influencing the outcome.

Patients and methods This prospective study included 50 mechanically ventilated COPD patients. For all patients, arterial blood gas analysis and vital data (before intubation, before extubation, and 30 min after extubation), complications of MV, the length of ICU stay, duration of MV, different trials of weaning from MV, and outcome were documented.

Results Nonsurvivors were significantly older (68.1 ± 10.3 vs. 60.7 ± 11.1, $P = 0.034$), had longer duration of MV (11.8 ± 10.4 vs. 5.4 ± 5.2, $P = 0.02$), prolonged ICU stay (17.7 ± 10.2 vs. 9.3 ± 5.6, $P = 0.01$), more frequent tracheostomy (4 vs. 1, $P = 0.018$), less liable to be weaned from the first trial (5 vs. 28, $P = 0.008$), and more complications of MV ($P = 0.04$). Only $PaCO_2$ before intubation differed significantly between survivors and nonsurvivors (92.6 ± 14.9 vs. 81.0 ± 18.2, $P = 0.025$). The length of ICU stay correlated significantly with both systolic and diastolic blood pressure ($P = 0.009$ and 0.022, respectively), complications of MV ($P = 0.001$), and the duration of MV ($P = 0.0001$).

Conclusion Several predictors can affect the outcome of COPD patients on MV, ultimately increasing the length of stay and mortality rate, including age, failure of several trials of weaning, presence of ventilator-associated pneumonia, adult respiratory distress syndrome, presence of tracheostomy, and prolonged MV duration.

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Keywords: chronic obstructive pulmonary disease, intensive care unit, mechanical ventilation, outcome

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Introduction

By 2020, chronic obstructive pulmonary disease (COPD) will be the third leading cause of death worldwide [1]. Hospitalization because of acute exacerbation is an important part of the care of patients with COPD whether these patients need mechanical ventilation (MV) or not [2]. The mortality rate of COPD patients who need invasive MV ranges from 6 to 24% [3].

The outcome of these patients with COPD who need invasive MV is altered by several factors such as severity of underlying lung disease, severity of acute illness, advanced age, and development of ventilator-associated pneumonia (VAP) during ICU stay [4].

Earlier studies have found that there several factors influence reintubation after extubation of COPD patients such as use of continuous intravenous sedation, longer duration of MV, and the status of patients after extubation such as endotracheal secretions, cough strength, and early increase of $PaCO_2$ after extubation [5]. Survival among mechanically ventilated patients also depends on the development of complications during ventilation and on patient management in the respiratory ICU [6].

The aim of this study was to assess the outcome of mechanically ventilated COPD patients admitted in the respiratory ICU in Ain Shams University Hospitals and the factors influencing the outcome.

Patients and methods

This prospective observational study included 50 mechanically ventilated COPD patients admitted to the respiratory ICU at Ain shams University Hospitals from January 2011 to December 2011. For all patients, the following were documented: detailed assessment of medical history before MV (from the patients or relatives), local examination of the chest, comorbidities, plain chest radiography, arterial blood gas (ABG) analysis (before intubation, before extubation, and 30 min after extubation), complications of MV, the length of ICU stay, duration of MV, different trials of weaning from MV, and outcome. The study was approved by the institutional ethical committee.

Statistical analysis

Parametric numerical data were expressed as mean ± SD, whereas nonparametric numerical data were expressed as median, frequency, and percentage. Student's *t*-test was used to assess the statistical significance of the difference between the means of the two study group. The Mann–Whitney *U*-test was used to assess the statistical difference of nonparametric variables between the two study groups. A χ^2-test was used to examine the relationship between two qualitative variables. Fisher's exact test was used to examine the relationship between two qualitative variables when the expected count is less than 5 in more than 20% of cells. The Kruskal–Wallis test was used to assess the statistical significance of the difference in nonparametric numerical variables between more than two study groups. Pearson's correlation was used to assess the correlation between different variables. Statistical significance was set at *P* value less than 0.05. Statistical analyses were carried out using the statistical package for social sciences software (SPSS, version 15.0; SPSS Inc., Chicago, Illinois, USA) for Windows.

Results

Table 1 shows the characteristics of all the patients included.

Comparison between survivors and nonsurvivors showed that nonsurvivors were significantly older (68.1 ± 10.3 vs. 60.7 ± 11.1, *P* = 0.034), had longer duration of MV (11.8 ± 10.4 vs. 5.4 ± 5.2, *P* = 0.02), prolonged ICU stay (17.7 ± 10.2 vs. 9.3 ± 5.6, *P* = 0.01), more frequent tracheostomy (4 vs. 1, *P* = 0.018), less liable to be weaned from the first trial (5 vs. 28, *P* = 0.008), and more complications of MV (*P* = 0.04) (Table 2).

ABG analysis parameters and vital data were compared among survivors and nonsurvivors on admission, before intubation, before extubation, and 30 min after extubation; only $PaCO_2$ before intubation differed significantly between survivors and nonsurvivors (92.6 ± 14.9 vs. 81.0 ± 18.2, *P* = 0.025) (Tables 3–6), whereas the correlation between length of ICU stay and both admission ABG analysis and vital data showed that the only significant correlations were those of systolic and diastolic blood pressure (*P* = 0.009 and 0.022, respectively) (Table 7 and Figs 1 and 2).

The correlation between comorbidities, complications of MV, and length of ICU stay showed that only complications of MV correlated significantly (*P* = 0.001; Table 8).

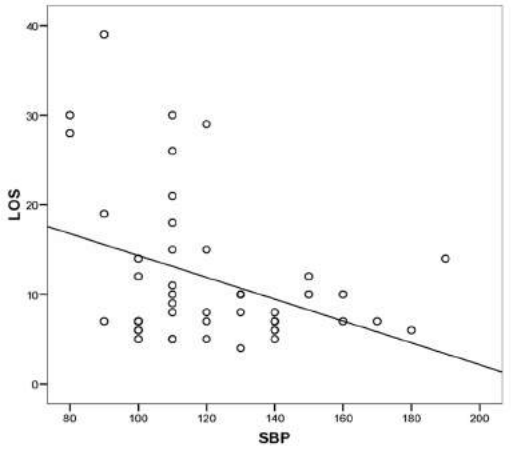
The duration of MV correlated significantly with the length of stay in ICU (*P* = 0.0001; Table 9 and Fig. 3).

Table 1 Characteristics of the patients included

Age (years)	62 ± 11.3
Sex (male/female) [*N* (%)]	45/5 (90/10)
Comorbidities [*N* (%)]	
No	24 (48)
Yes	26 (52)
Smoking [*N* (%)]	
Nonsmoker	3 (6)
Smoker	24 (48)
Ex-smoker	23 (46)
Duration of MV (days)	7.2 ± 7.5
Length of ICU stay (days)	11.7 ± 8
Trials of weaning [*N* (%)]	
No	2 (4)
Self-extubation	2 (4)
1	33 (66)
2	4 (8)
3	3 (6)
4	3 (6)
5	1 (2)
6	2 (4)
Complications of MV [*N* (%)]	
No	34 (68)
VAP	13 (26)
VAP and ARDS	2 (4)
VAP and AKI	1 (2)
Outcome [*N* (%)]	
Survivors	36 (72)
Nonsurvivors	14 (28)

AKI, acute kidney injury; ARDS, adult respiratory distress syndrome; MV, mechanical ventilation; *N*, Number; VAP, ventilator-associated pneumonia.

Fig. 1



Correlation between the length of ICU stay (LOS) and systolic blood pressure (SBP).

Discussion

This study was carried out in an attempt to investigate the outcome of mechanically ventilated COPD patients admitted in the respiratory ICU

Table 2 Comparison between survivors and nonsurvivors

Variables	Survivors (*N* = 36)	Nonsurvivors (*N* = 14)	*P*
Age (years)	60.7 ± 11.1	68.1 ± 10.3	0.034
Sex (male/female) (*N*)	33/3	12/2	0.611
Comorbidities (*N*)			
No	16	8	0.979
Yes	20	6	
Smoking (*N*)			
Nonsmoker	2	1	0.162
Smoker	20	4	
Ex-smoker	14	9	
Duration of MV (days)	5.4 ± 5.2	11.8 ± 10.4	0.02
Length of ICU stay (days)	9.3 ± 5.6	17.7 ± 10.2	0.01
Tracheostomy [*N* (%)]	1 (20)	4 (80)	0.018
Weaning (*N*)			
No	2	2	0.310
Yes	34	12	
Trials of weaning (*N*)			
1	28	5	0.008
2	2	2	0.310
3	2	1	1
4	1	2	0.186
5	0	1	0.280
6	1	1	0.486
Complications of MV (*N*)			
No	28	6	0.04
VAP	7	6	0.149
VAP and ARDS	1	1	0.486
VAP and AKI	0	1	0.280

AKI, acute kidney injury; ARDS, adult respiratory distress syndrome; MV, mechanical ventilation; VAP, ventilator-associated pneumonia.

Table 3 Comparison between survivors and nonsurvivors in admission arterial blood gas analysis and vital data

Variables	Survivors	Nonsurvivors	*P*
pH	7.2 ± 0.1	7.3 ± 0.1	0.554
$PaCO_2$	87.9 ± 15.8	78.6 ± 27.3	0.142
PaO_2	47.7 ± 20.2	43.7 ± 20.5	0.534
HCO_3	32.0 ± 9.1	31.4 ± 9.2	0.836
SO_2	67.1 ± 17.9	60.8 ± 21.2	0.292
Pulse	111.4 ± 18.2	110.6 ± 11.9	0.873
SBP	123.2 ± 22.0	117.1 ± 31.7	0.449
DBP	75.0 ± 13.8	71.4 ± 20.3	0.483
RR	33.0 ± 6.6	33.7 ± 9.4	0.453

DBP, diastolic blood pressure; RR, respiratory rate; SBP, systolic blood pressure.

Table 4 Comparison between survivors and nonsurvivors in arterial blood gas analysis and vital data before intubation

Variables	Survivors	Nonsurvivors	*P*
pH	7.2 ± 0.1	7.2 ± 0.1	0.804
$PaCO_2$	92.6 ± 14.9	81.0 ± 18.2	0.025
PaO_2	46.9 ± 14.1	55.1 ± 25.5	0.271
HCO_3	32.4 ± 8.9	29.3 ± 6.9	0.247
SO_2	67.6 ± 17.4	69.6 ± 21.0	0.737
Pulse	111.3 ± 12.9	110.7 ± 16.1	0.903
SBP	117.8 ± 25.4	119.3 ± 27.9	0.855
DBP	73.9 ± 17.3	71.4 ± 16.6	0.650
RR	33.2 ± 6.5	32.4 ± 5.9	0.675

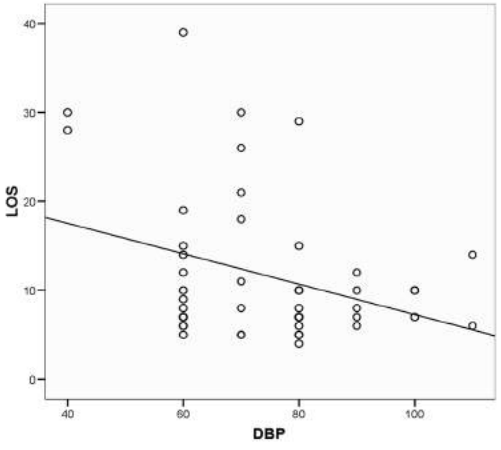
DBP, diastolic blood pressure; RR, respiratory rate; SBP, systolic blood pressure.

Table 5 Comparison between survivors and nonsurvivors in arterial blood gas analysis and vital data before extubation

Variables	Survivors	Nonsurvivors	*P*
pH	7.5 ± 0.1	7.4 ± 0	0.689
$PaCO_2$	50.2 ± 10.1	48.3 ± 9.4	0.615
PaO_2	77.57 ± 27.57	78.0 ± 21.8	0.967
HCO_3	34.5 ± 6.9	32.8 ± 5.1	0.512
SO_2	92.7 ± 6.3	93.9 ± 5.1	0.624
Pulse	100.1 ± 10.5	95.8 ± 13.5	0.409
SBP	123.1 ± 13.0	126.3 ± 10.6	0.534
DBP	78.3 ± 7.9	77.5 ± 7.1	0.786
RR	20.7 ± 4.0	21.5 ± 1.4	0.604

DBP, diastolic blood pressure; RR, respiratory rate; SBP, systolic blood pressure.

Fig. 2



Correlation between the length of ICU stay (LOS) and diastolic blood pressure (DBP).

and to highlight the main factors affecting this outcome. Our results showed that 36 (72%) patients were survivors, whereas 14 (28%) patients were nonsurvivors. Other studies [6,7] reported similar or very close mortality figures. Older COPD patients on MV were at a higher risk for hospital mortality. The fact that age can influence the outcome was also observed in several studies [8,9]. Conversely, other studies [7,10] showed that there was no impact of advanced age on the outcome of mechanically ventilated COPD patients. This discrepancy in results can be attributed to the differences in patient selection.

Table 6 Comparison between survivors and nonsurvivors in arterial blood gas analysis and vital data 30 min after extubation

Variables	Survivors	Nonsurvivors	*P*
pH	7.4 ± 0.1	7.4 ± 0.2	0.537
$PaCO_2$	54.7 ± 11.3	59.1 ± 25.4	0.445
PaO_2	66.6 ± 15.7	64.3 ± 14.0	0.686
HCO_3	33.2 ± 6.3	33.0 ± 3.4	0.941
SO_2	90.7 ± 4.8	88.9 ± 8.5	0.413
Pulse	100.9 ± 10.9	108.1 ± 13.0	0.177
SBP	122.9 ± 15.8	116.3 ± 17.7	0.303
DBP	76.0 ± 11.7	71.3 ± 13.6	0.382
RR	23.0 ± 3.7	26.1 ± 6.2	0.067

DBP, diastolic blood pressure; RR, respiratory rate; SBP, systolic blood pressure.

Table 7 Correlation between length of intensive care unit stay and admission arterial blood gas analysis and vital data

Variables	*P*	*r*
pH	0.864	0.025
$PaCO_2$	0.837	–0.030
PaO_2	0.258	0.163
HCO_3	0.767	0.043
SO_2	0.614	0.073
Pulse	0.574	–0.081
SBP	0.009	–0.373
DBP	0.022	–0.331
RR	0.981	–0.003

DBP, diastolic blood pressure; RR, respiratory rate; SBP, systolic blood pressure.

Table 8 Correlation between comorbidities, complications of mechanical ventilation, and length of stay in intensive care unit

Variables	LOS	*P*
Comorbidities		
No	10.5 ± 7.7	0.449
Yes	12.3 ± 8.3	
Complication of MV		
No	8.4 ± 3.2	0.001
Yes	18.7 ± 10.5	

LOS, length of stay; MV, mechanical ventilation.

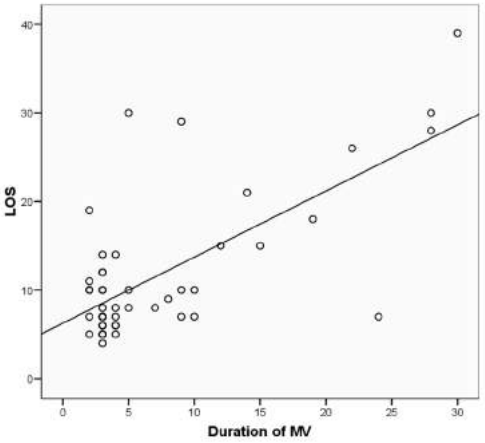
Table 9 Correlation between duration of mechanical ventilation and length of stay in intensive care unit

Variables	LOS	
	r	*P*
Duration of MV	0.698	0.0001

LOS, length of stay; MV, mechanical ventilation.

Although male sex and smoking are considered important risk factors for COPD, yet, they did not affect the outcome in our study. This was in accordance with the work published by Epstien and Vuong [11] as well as Luhr *et al*. [12], where sex did not play a role as a predictor of survival among mechanically ventilated COPD patients.

Fig. 3



Correlation between the length of ICU stay (LOS) and the duration of Mechanical ventilation (MV).

Several ICU variables significantly affected the outcome of patients and increased the risk of mortality including the length of ICU stay, duration of MV, the presence of tracheostomy, and the complications of MV. The higher mortality could be attributed to the presence of complications such as VAP, adult respiratory distress syndrome (ARDS), and repeated attempts of unsuccessful weaning. In contrast, Engoren *et al*. [9] found that hospital mortality among adult patients with tracheostomy on MV was low. This difference may be related to improved medical care at his place of work or differences in practice patterns as well as the criteria for selection of candidates for tracheostomy. Moreover, the mortality rate was low in patients who had successful weaning from the first trial in contrast to the high mortality found in patients who had more than one weaning trial. These results were in agreement with the work published by Nevins and Epstein [7], who found that patients in whom planned extubation attempts failed had higher mortality rates, longer duration of MV, and longer ICU and hospital length of stay. The results also showed that the mortality rate was less in patients who had no complications on MV. Nerveless, VAP or VAP in combination with ARDS and acute kidney injury did not affect the mortality rate. This was in contrast to the results of Nseir *et al*. [13], who reported that VAP was associated with higher mortality rates, longer duration of MV, and prolonged ICU stay in COPD patients.

Vital data and different ABG analysis variables assessed on ICU admission, before intubation, before extubation, and after extubation did affect the outcome of patients, except for the $PaCO_2$ taken before intubation, which significantly affected the patients' outcome, being higher in the survivors in comparison with the nonsurvivors. This was similar to the work

published by Nevins and Epstein [7], who reported that ABG analysis on admission plays no role as a predictor of prolonged length of stay among COPD patients requiring MV. Similarly, Khilnani *et al.* [5] found that the mean $PaCO_2$ and the mean HCO_3 level among survivors were higher than nonsurvivors, whereas the mean pH among survivors did not differ significantly between survivors in comparison with nonsurvivors. In contrast, Esteban *et al.* [6] and Groenewegen *et al.* [14] reported high $PaCO_2$ levels on admission to be associated with worse outcome and also a risk factor for mortality. The level of hypercapnia suggested chronic alveolar hypoventilation, which reflects the severity of the underlying respiratory condition. In addition, Afessa *et al.* [15] reported that low pH on admission was associated with increased mortality, whereas the $PaCO_2$ level on admission played no role as a predictor of mortality. Moreover, our results showed that the admission ABG analysis did not correlate with the length of ICU stay.

Our results were in agreement with those of another study [16], in which comorbid diseases did not influence the survival. However, Ai-Ping *et al.* [8] found that hospital mortality increased in patients who had cardiac diseases. In addition, the presence of comorbidities did not correlate with the length of ICU stay. This was in contrast to the results of Nseir *et al.* [13] where the presence of renal and cardiac failure on ICU admission was associated with prolonged ICU stay and higher hospital mortality. Our study found that there was a direct correlation between the duration of MV and the length of stay in ICU; increased duration of MV led to increased length of stay in the ICU. This finding was in agreement with that of Nevins and Epstein [7], who found that COPD patients who required MV for more than 72 h had higher mortality rate and prolonged length of stay in ICU.

From this study, it can be concluded that several predictors can affect the outcome of COPD patients on MV ultimately increasing the length of stay and mortality rate. These predictors include age, failure of several trials of weaning, presence of VAP, ARDS, presence of tracheostomy, and prolonged MV duration.

Finally, it is recommended to administer a plan to manage the resultant predictors to decrease the mortality rate and the length of stay in respiratory ICU among COPD patients on MV.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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